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New capabilities of the software to support digitization of astronomical photographic plates

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Abstract

- In this article, we announce improvements to two applications for digitizing astronomical photographic plates and developing a new one.
- In the software for creating the header of fits file using the data from WFPDB (wfpdb.org) we add feature for processing data for multiexposure plates.
- A new functionality of application for updating fits header allow us to complete fits header for fits files obtained from ImageMagic application.
- The development of virtual observatories has prompted us to realize a convertor of fits header to GAVO (www.g-vo.org) standard.

Content

- Wide-Field Plate Database
- Plate digitization
- Header
  - Header software
  - GAVO
  - Update header
- Processing image
  - tif2fits software
  - UpdataFitsHdr software
- Multiple exposure

Wide-Field Plate Database

- There are about 2 475 000 photographic plates all over the world.
- Wide-Field Plate Database (`www.wfpdb.org`) is WEB-based database that contains meta-data for more than 600 thousand plates.
- It is one wide-field unique telescope, giving access to unique photographic astronomical observations, done systematically in the period 1880 – 2000!
- The Catalogue of Wide-Field Plate Indexes contains meta-data for plates.
- For every plate many details are stored in the database: the coordinates of the plate center, the date and time of the observation, object name and type, method of observation, duration of exposures, type of emulsion, the size of the plate, the quality of the plate, the name of the observer, etc.

The meta-data of the plates are distributed in 6 plain-text files.

- The most important information is in the `maindata` file:
```
ESO040 007863 053517-052328 19850114012100 ORION M42-43 NGC1976  S42 6120.0KODAK
 IIaO        Pg161611111
```
- Availability file:
```
ESO040 007863  PLATE IS AVIALABLE AT THE WFPDB DEPOSITORY, SOFIA,  BULGARIA:
 milcho.tsvetkov@gmail.com
```
- Notes file:
```
ESO040 007863 ORIG_COORD:053400-052400 ST.ST=     ST.END=0620 UT.ST=0121
 UT.END=0329   MULTIP. EXPOS=6X20  FL! ANON     L
 EXP1-6_UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-02:47,
 02:48-03:08,03:09-03:29;
```
- Observer file:
```
ESO040 007863  W.SEITTER
```
- Quality file:
```
ESO040 007863  3    ARCSEC SEEINGS
```
- Digitization file:
```
ESO040 007863 DIGITISED WITH PDS2020 AT AIM, AND IN THE WFPDB WITH THE
 FB SCANNER EPSON PERFECTION V700 20MIC PIXEL(1200DPI)
```

Plate image – Digitized plate (16-bit grayscale) image (FITS file), with high resolution aiming photometric and astrometric measurements.

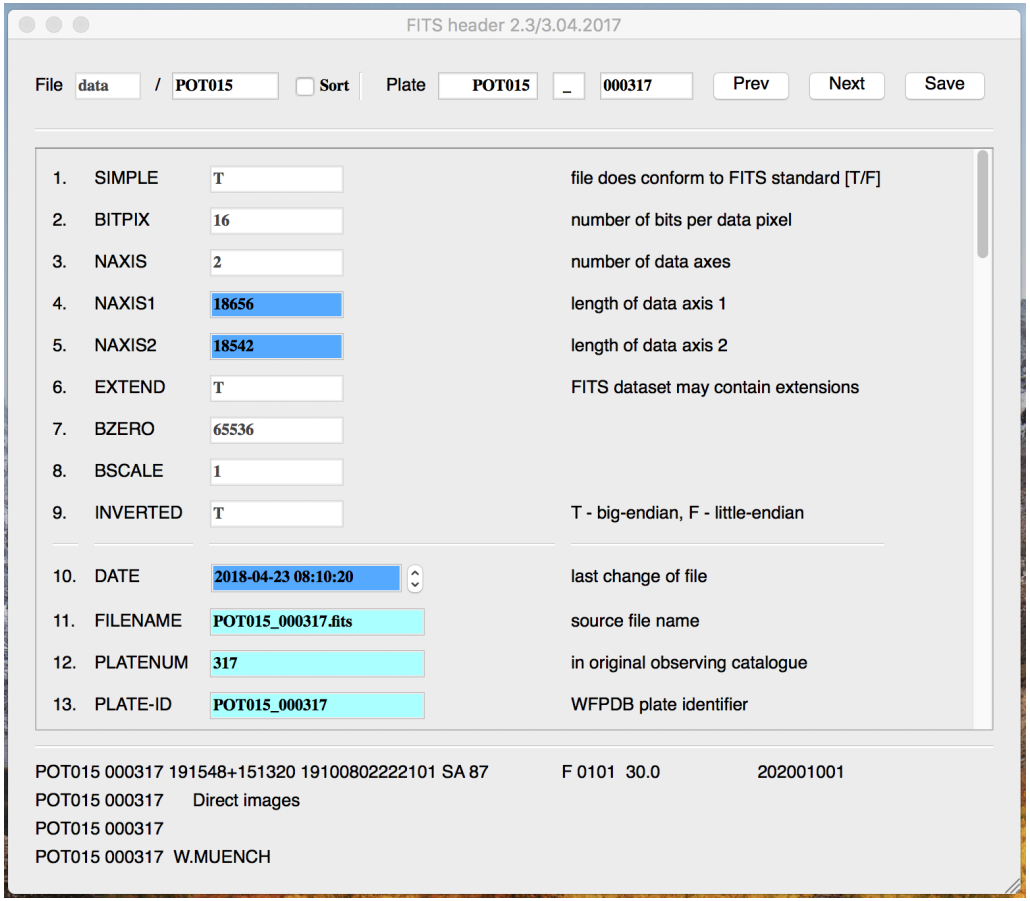
The process of plate digitization:

- Scan the plate (image) – `.tif` (row-tiff) file
  - Hardware: flatbed scanner
  - Software: VueScan
- Complete metadata (header) – `.hdr` file
  - Transfer data from WFPDB: header software
  - Add actual data for scanning, time, etc.: header software
- Merge image and header files – `.fits` file
  - tif2fits software
  - ImageMagic software + UpdateFitsHdr software

Header

Fits header (.hdr) – Plain text file containing FITS file header for easy on-line access to the plate meta-data.

- Most of the data for fits header can be extracted from WFPDB.
- Additional data can be entered manually or automaticaly.



Header

Header ”standards”:

- Our header ()
- German Astrophysical Virtual Observatory (GAVO) header

GAVO header sections:

- ”Basic data”
- Original data of observation
- Observatory and instrument
- Photographic plate
- Derived observation data
- Scan details
- Data files

Convertors for various "standarts":

- WFPDB → .hdr
- .hdr → .hdrg
- .hdrf → .hdrg

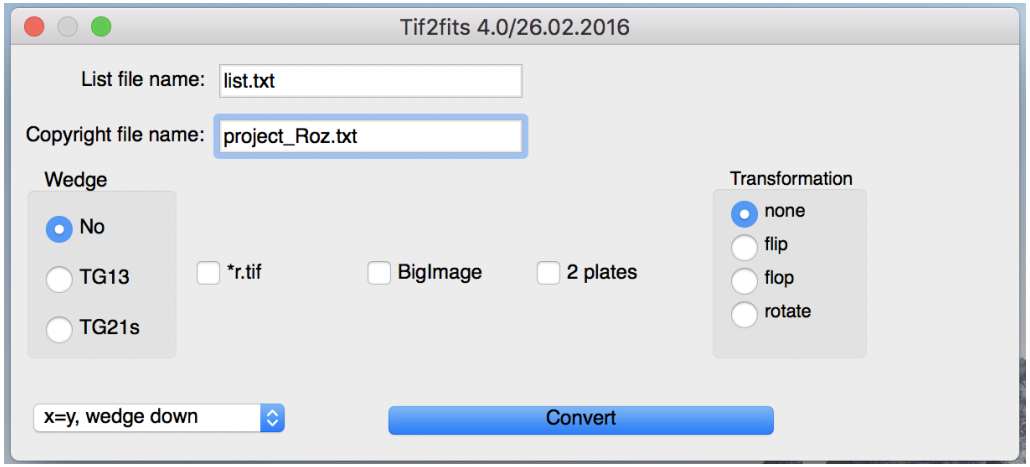
Example.

.hdrf: `UT = '1911-02-02 01:31:39' / date and UT at mean epoch`

.hdrg: `DATE-AVG= '1911-02-02T01:31:39Z' / UT d/t mid-point of observation`

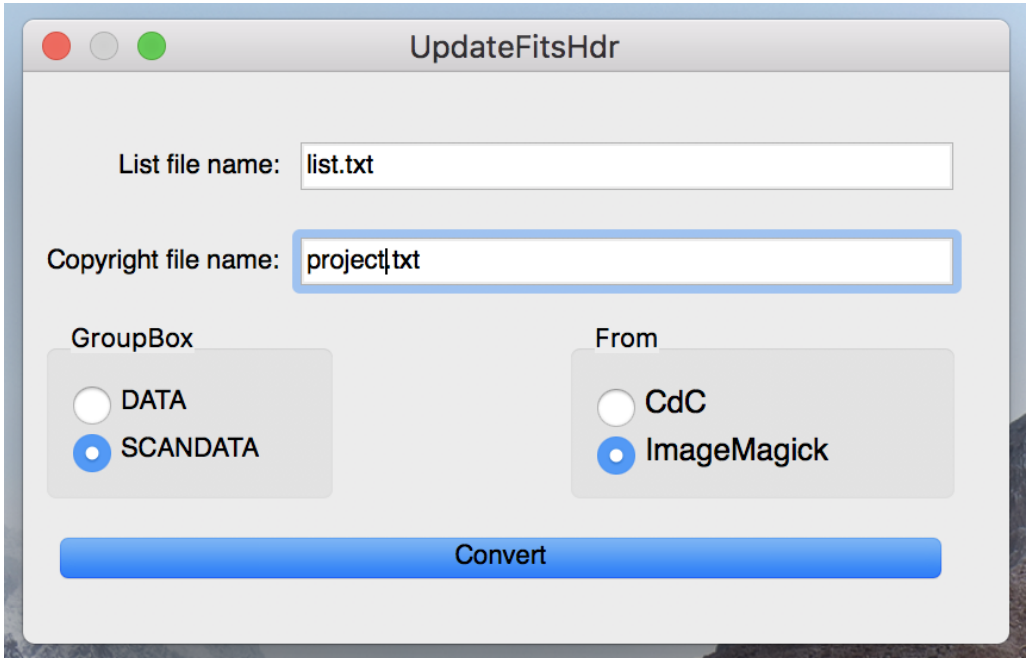
Processing image

- tif2fits software
- .tif + .hdr → .fits + .hdrf

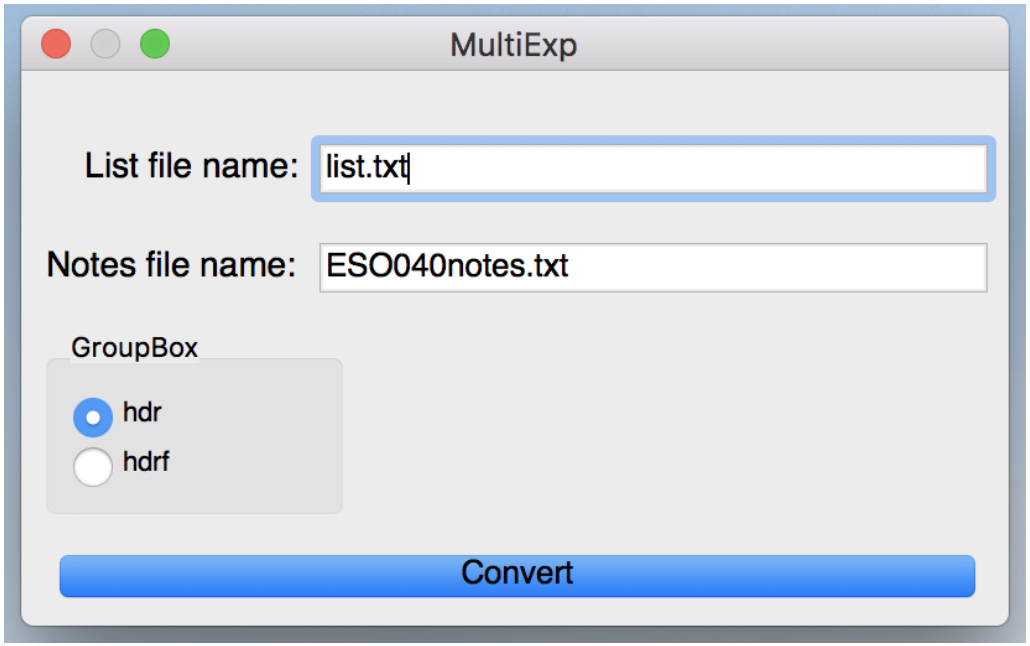


Processing image

- ImageMagic: .tif $\rightarrow$ .fits (small header)
- UpdateFitsHdr: .fits + .hdr $\rightarrow$ .fits



Header with fixed number of lines vs. header with variable number of lines



Notes file

```
UT_STARTUT_END=01:21-01:41,01:42-02:02,02:03-02:23,02:27-02:47,02:48-03:08,03:09-03:29;
.hdrg
DT-OBS1 = '1985-01-10T01:21:00Z'
DT-AVG1 = '1985-01-10T01:31:00Z'
DT-END1 = '1985-01-10T01:41:00Z'
EXPTIM1 =                 1200.0
DT-OBS2 = '1985-01-10T01:42:00Z'
...
```

`https://github.com/nkirov`

- `plate-FITS-header`
- `tif2fits`
- `update_fits_hdr`
- `multiexpose`*

Qt – a cross-platform application framework based on C++

Thank you for your attention.